

Implementing an Arbitrary One-Qubit Gate with the Single Cooper Pair Box Approach: Specific Calculations

P. M. Echternach and C. P. Williams

Jet Propulsion Laboratory

California Institute of Technology

4800 Oak Grove Drive, Pasadena, CA 91109-8099, USA

We have devised a method to generate arbitrary one-qubit gates within the Single Cooper Pair Box approach to quantum computing. We assume tunnel junctions split in a SQUID loop configuration allowing for tuning of the Josephson coupling. We are able to decompose an arbitrary transformation in three stages with different values for Josephson coupling and gate voltages. During the first and last steps the Josephson coupling is set to zero. The intermediate step is performed with a finite value of the Josephson coupling. The values of the Josephson Coupling and gate voltages are related to the times spent at each stage and can be adjusted so currently available pulse generators can be used, subjected to the constraint that the energy difference between the eigenstates is much larger than the thermal energy $k_B T$. We will present specific calculations for Aluminum based and Niobium based Single Cooper Pair Boxes and describe our effort to fabricate and characterize qubits. We are also working on extending the present scheme to implement a controlled-NOT gate.